Forty Years of Space Research

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この論文は、1998年7月12～19日に、名古屋で国際学術連合（ＩＣＳＵ）傘下の宇宙研究会議（COSPAR）の第40回総会が開催された際に、小田稔学長がその開会式のための記念論文としてまとめたものです。

First, I would like to offer my congratulations to Profs. Herendel（COSPAR会長、マックスプランク研究所長）& Nishida（COSPAR日本委員長、宇宙科学研究所長）and other organizing committee members for the opening of this 40th Anniversary of COSPAR's General Assembly. I feel very much honored to be given this opportunity of presenting a talk in this opening ceremony, as indicated by Fig. 1.

Figure 2 exhibits how the heart of today's physics has been approached by space researches and other disciplines from various other directions. Among a variety of disciplines of space researches, which pushed forwards the frontier of Science, here I concentrate on space asfrophysics. As is seen, "Serendipitous approaches" and "Small missions approaches", are now emphasized.

Another series of diagrams in Fig.3 represent the historical developments of astrophysics. For each diagram of decade, major problems in astrophysics are exhibited. The ordinate for each diagram represents the degree of surprise or serendipity to North, and the depth in understanding to South. Abscissas represent from left to right cosmological, galactic and stellar interests. Among the various disciplines of interest, in the following I pick up a few topics：i.e. X-ray astronomy, space VLBI and Solar physics.

The next diagram, Fig. 4, exhibits how X-ray astronomy has developed since the first discovery of the celestial X-sources in 1962-3, towards three directions of observational interests as indicated, by underlines.

35 years have passed since its birth. At present, two major international X-ray observatories, ASCA and ROSAT, and other satellites are actively at work as indicated. ASCA which stands for Advanced Satellite for Cosmological Astrophysics follows the name of Japan's Asuka Dynasty of 6th-7th century, when Buddhism arts flourished the most, and ROSAT, of course, is the Roentgen Satellite.

X-ray astronomy had brought imaginary objects like neutron star, black hole and others to the realities. Despite continuos efforts of X-ray astronomers, several objects remain as yet unsolved or mysterious. We may raise as the examples：Quasi-Periodic-Oscillations

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(QPO), Rapid Bursters (RB), Gamma-Ray-Bursts (GRB) and X-ray Quasars (XQSO), and also "jet" has become common dynamic phenomena at all hierarchies of astrophysical objects.

Perhaps, for the first time in the COSPAR Assembly "X-ray" has become one of the major sessions. In fact, since this morning Prof. Makishima has attracted a roomful of X-ray astronomers in the session.

I would show a few old photos and cartoons to represent the early history of X-ray astronomy. The first photograph, Fig. 5, which was taken by Prof. Rossi's little boy when we were walking along the beach of Cape Cod on 1962. The cartoon, Fig.6, indicates that Rossi asked many of his friends and colleagues what is the physical mechanism of emission of celestial X-rays. One episode is that Geoff Burbidge as usual producing one theory per day claimed that a dense configuration of stars at the center of Galaxy produces a dense hot plasma by means of mutual collisions of the stars which forms the hot thermal X-ray source. Soon later Herb Friedman performed a rocket observation at an instance when the Galactic center was below the horizon, and then he found the X-ray source was bright, i.e. the source was not the Galactic Center ! As indicated in the cartoon, then the key question was whether the source was diffuse, or nebular or stellar and point-source. To this question the concept of modulation collimator appeared, Fig. 7. For some time in NASA this collimator was called "ODA" collimator. To the question "what is ODA?" jokingly answered was "Office of Defence Analysis?". Rossi called the collimator a Bamboo Screen collimator referring to his retrospect of the stay in Kyoto's Ryokan, Fig. 8, 9, 10 and 11 indicate the uses of the modulation collimater for early hintarcal steps in X-ray astronomy.

Since last year when the satellite "Haluca" was launched in February, 1997 the space-VLBI marked revolutionary steps in radio astronomy. Again, let me show you old photos and cartoons which show historical steps of radio astronomy in Japan.

The first photo, Fig. 12 is for gathering of Japan's renowned physicists at the Shimada Branch of Japan's Naval Research Laboratory which conrrespond to the Radiation Lab of MIT which still remaing as the Bld. 20 of MIT.

Immediately after the war when activities in experimental physics in Japan were totally defeated, one of the first activities was Koichi Shimoda's radio observation of the partial eclipse of the sun, Fig. 13. And soon radio observations of the sun had grown to be active in Tokyo and Osaka, Fig. 14 and 15.

The concept of radio interferometry had developed in late '40s in Australia, UK, US, NL and Japan soon after the end of the World War II, inspired by the development of Radar technology during the war. Figure 16 exhibit how the radio interferometry was initiated in Australia and, then, developed in Osaka.

The concept of the interferometry soon, almost automatically led to the idea of VLBI and then to the idea of Space VLBI . The photos, Fig. 17, 18 and 19, may give you some idea

of the Spcce orbiting parabola. The parabola is made of fine-gold-plated mesh of Molybdenum which is almost as fine as lady's stocking. 8-10 meter dia. parabola is folded by "ORIGAMI" techniques, when it is launched and then it is stretched in the orbit, as indicated by Fig. 20 and 21.

The Space VLBI, named VSOP for the honor of Morimoto, world's widely known Liquor-lover, has been produced by the collaboration among Hirax, Hirosawa and their colleagues of ISAS also in collaboration with JPL, and NRAO via MIT and also with the colleagues of Australia. Photos, Fig. 22, were taken when they gathered at 12 Feb. on the occasion of the launch of Haluca Space VLBI from Uchinoura Space Station of ISAS.

The viewgraph, Fig. 23, shows examples of the images of QSO, AGN, obtained by VLBI with & without VSOP.

Hirax will present as one of the Interdisciplinary Talks later in the Session on the World's program of the Space VLBI.

Finally, following photos, Fig. 24, 25 and 26 show the program of observation with Solar X-ray satellite Yohkoh under Japan/US/UK Collaboration. The observations have made the Solar physics, not as old, second-hard physics, but again as important first class physics.

So much for old photos and cartoons, which conclude my personal visions of the 40 years history of space researches.

Some Old Stories on
Space Researches in
the Past 40 years

{ X-ray astronomy
Space VLBI
Solar Physics

Fig. 1

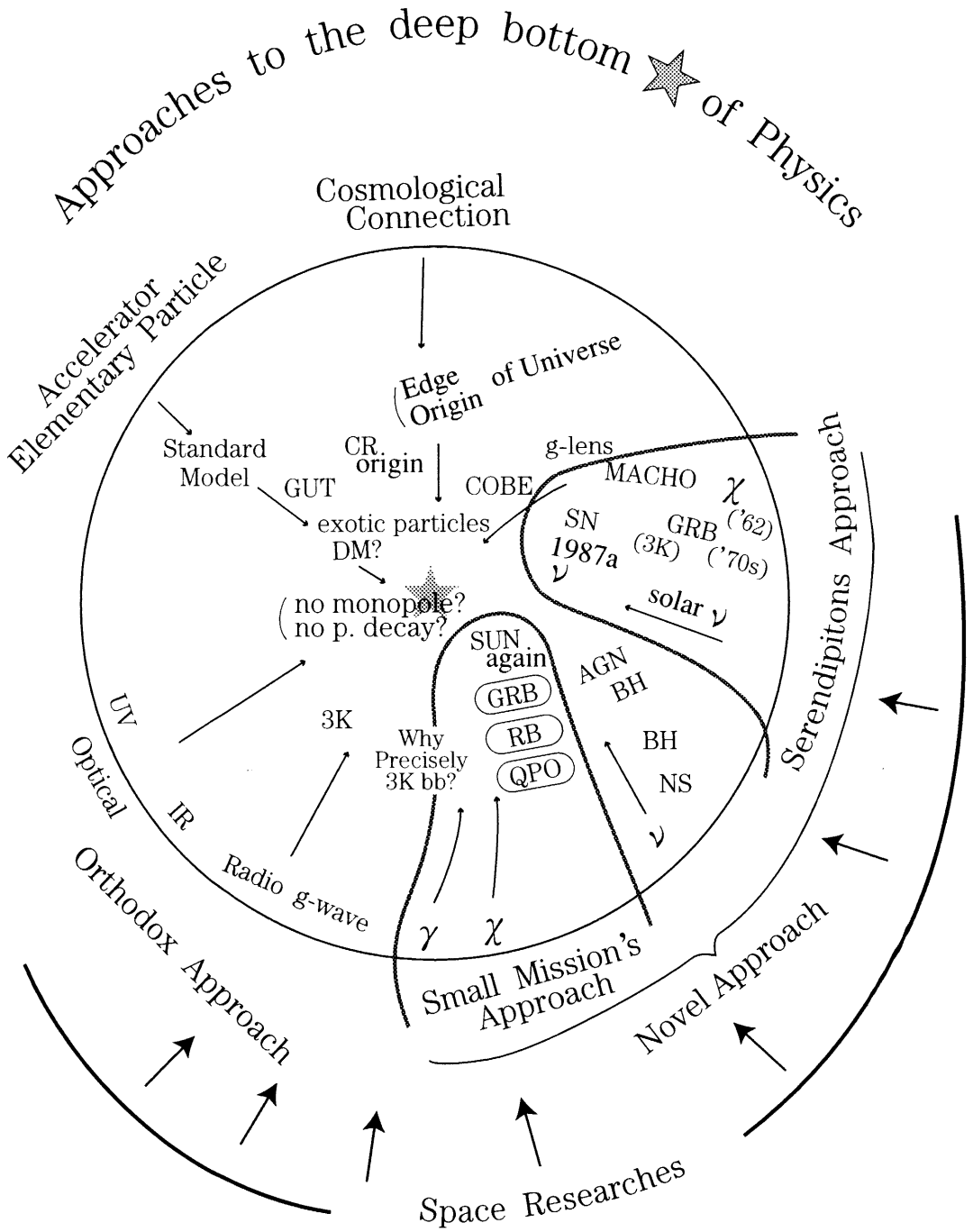

Approaches to the deep bottom of Physics
Cosmological Connection
Accelerator Elementary Particle
Edge Origin of Universe
Standard Model
GUT
CR origin
COBE
g-lens
MACHO
χ
SN 1987a
ν
GRB ('62) (3K) ('70s)
exotic particles DM?
no monopole? no p. decay?
solar ν
SUN again
AGN BH
GRB
RB
QPO
BH
NS
ν
3K
Why Precisely 3K bb?
UV
Optical
IR
Radio g-wave
γ
χ
Serendipitons Approach
Orthodox Approach
Small Mission's Approach
Novel Approach
Space Researches

Fig. 2

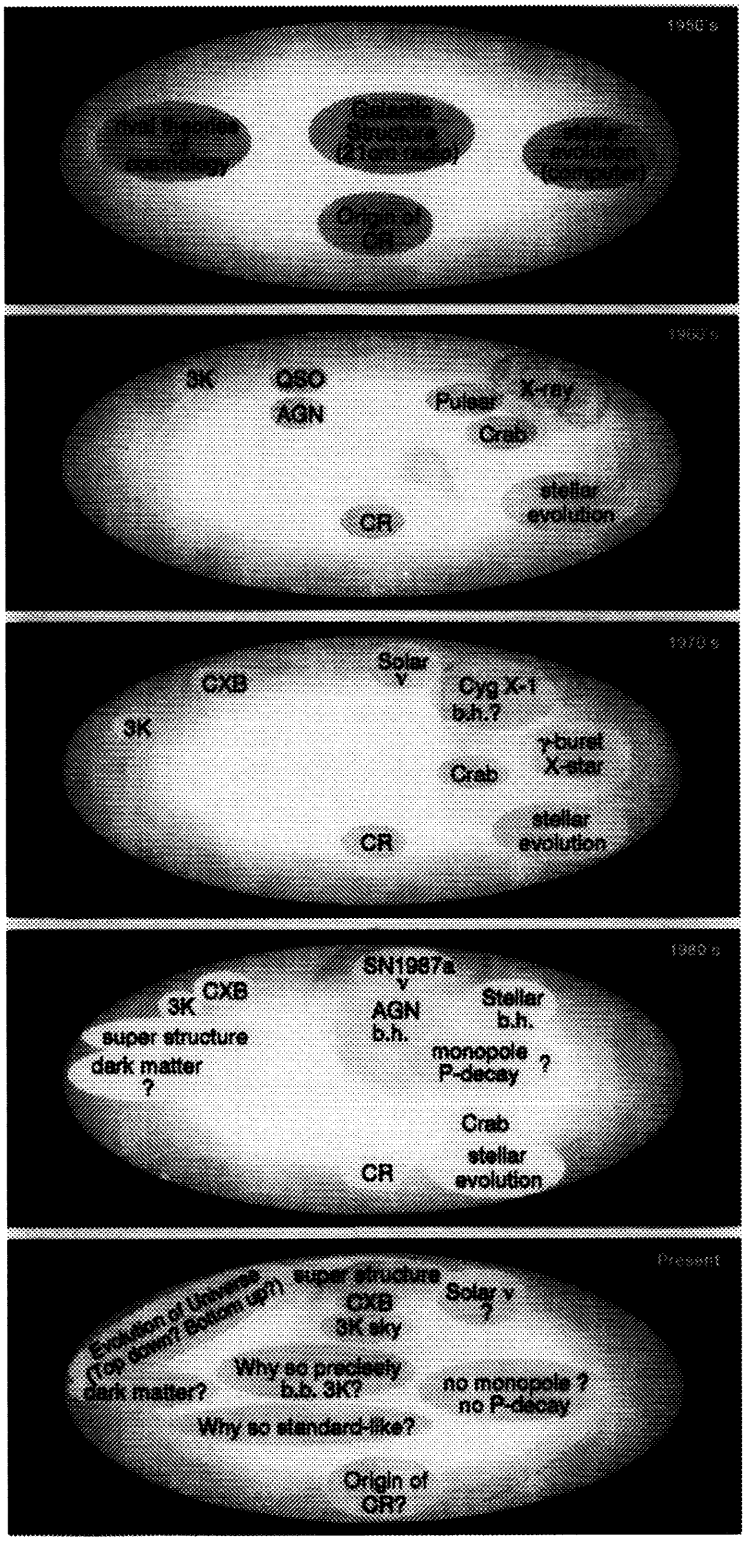
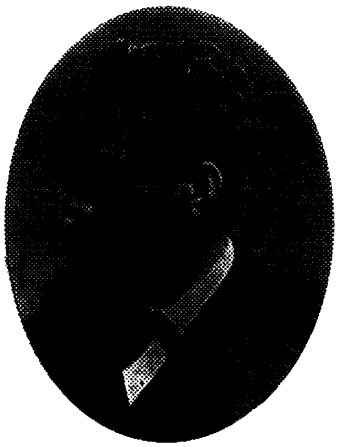


Fig. 3　Major problems in Astronomy

Statue of Maitreya Bodhisattva in Meditation
Chugu-ji Temple in Asca (6th ~ 7th C.)
(From Heibonsya's Encyclopedia, 1982)



Röntgen

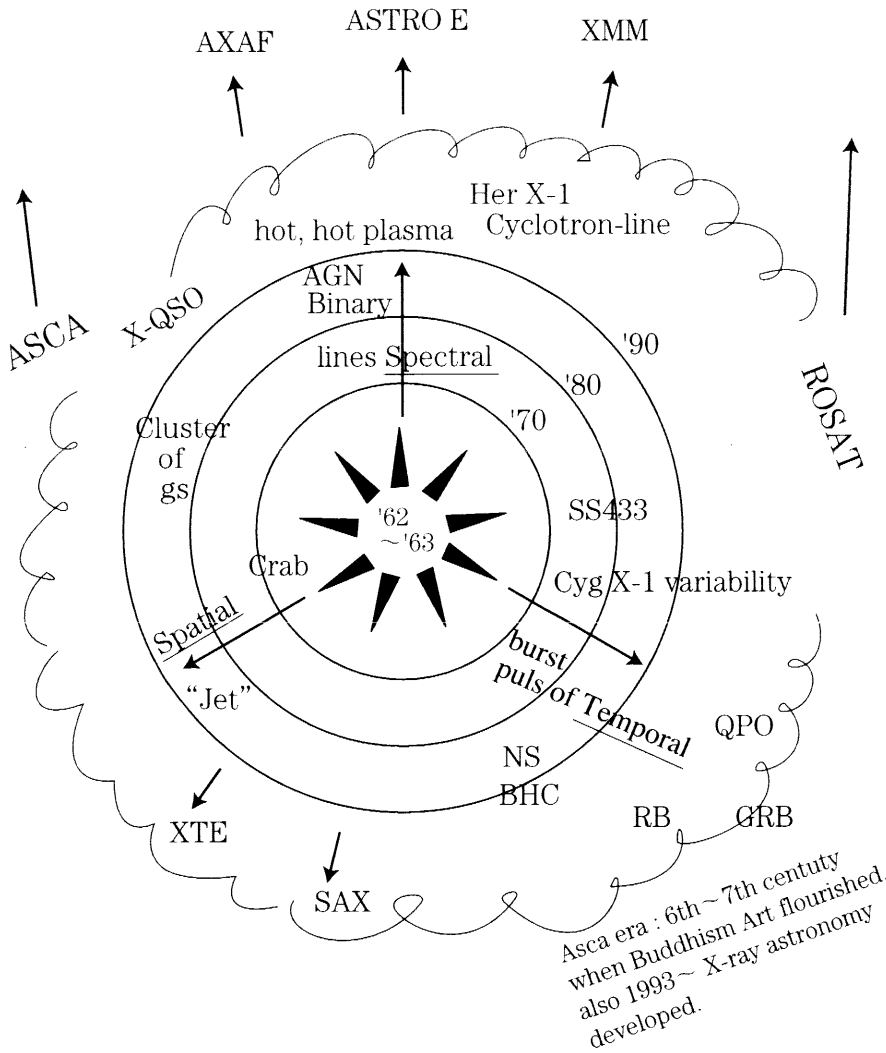


Fig. 4

" Why X-rays come from sky ? "

1962
Cape Cod

Fig. 5

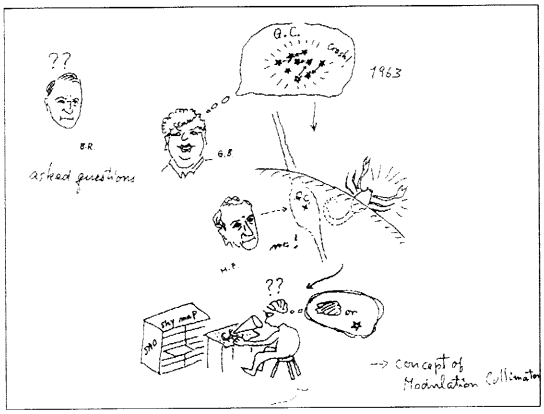


Fig. 6

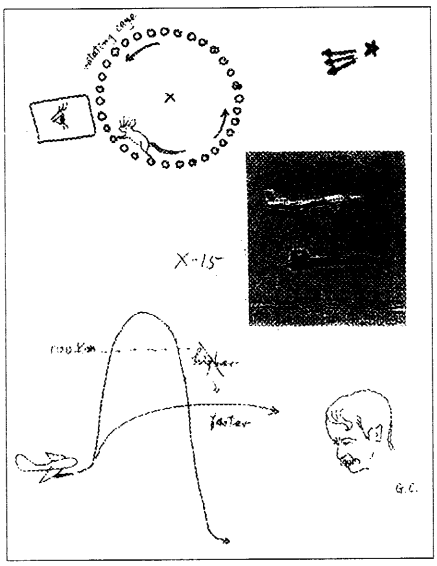
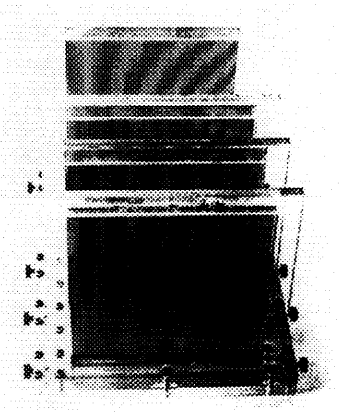
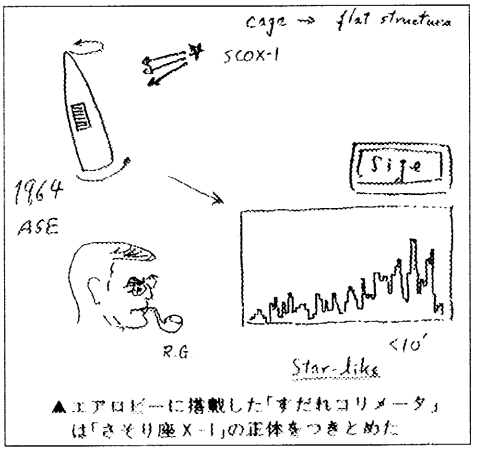


Fig. 7



Rossi : Bambro Screen in Kyoto
"Sudare"

Fig. 8



▲エアロビーに搭載した「すだれコリメータ」は「さそり座X-1」の正体をつきとめた

Fig. 9

Ogawara

Fig. 10

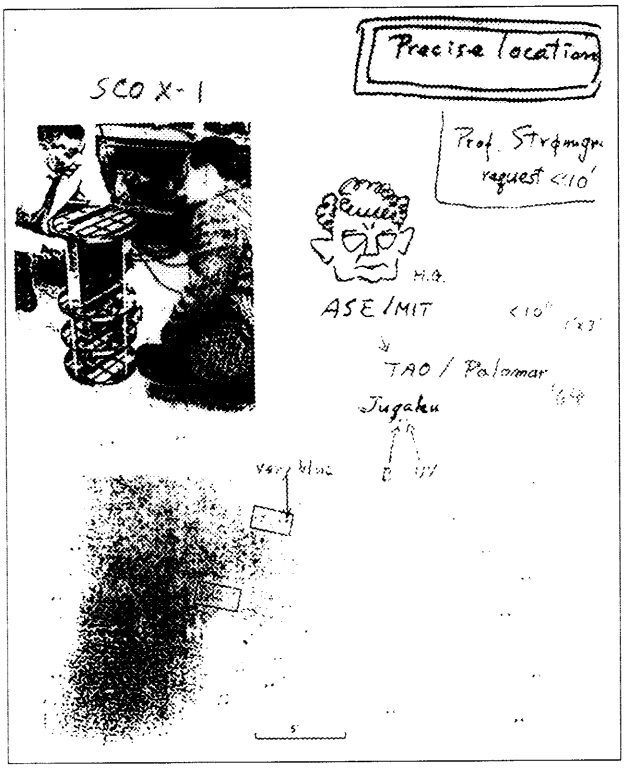
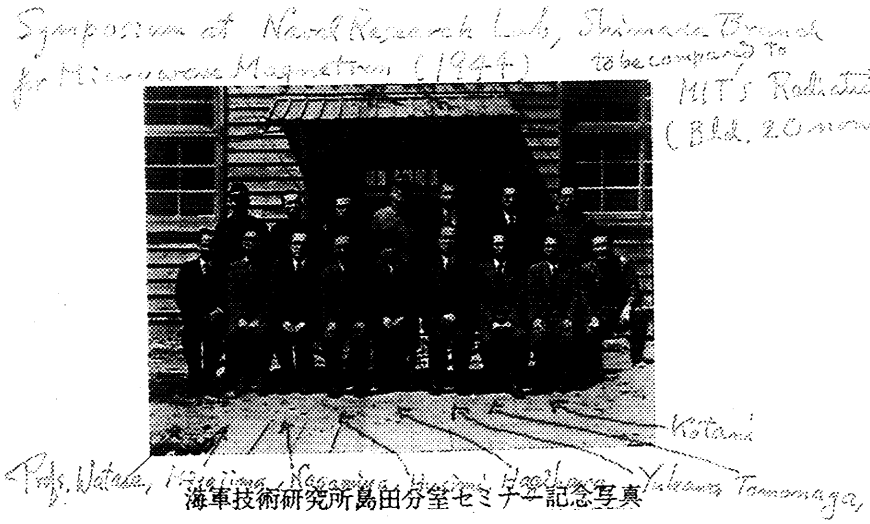


Fig. 11



海軍技術研究所島田分室セミナー記念写真

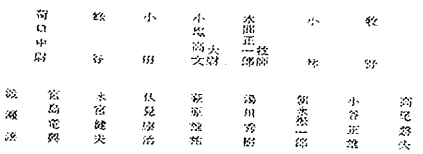


Fig. 12

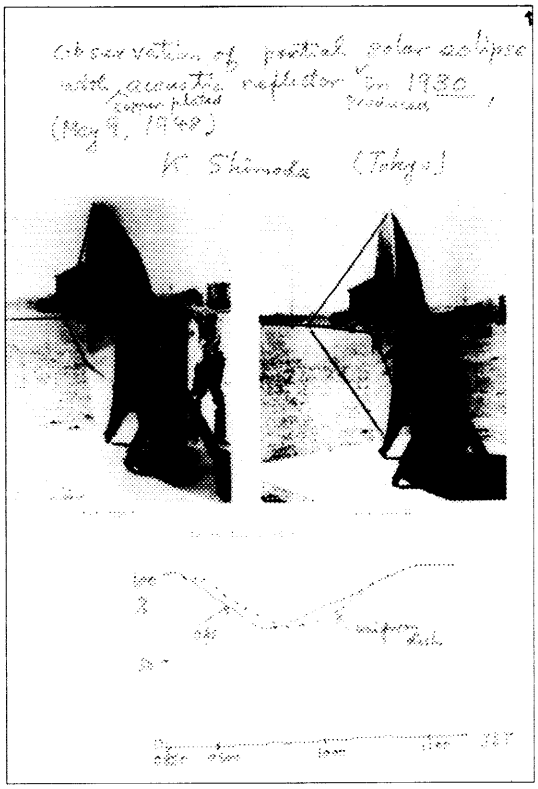


Fig. 13

200 MHz Antenna
1949 at Mitaka (Tokyo Astr. Obs)

First informal meeting of solar radio astronomers (?).

↑
late Prof. Hatanaka

Fig. 14

Early Microwave Telescope in Osaka
constructed with the war surplus radar parts

1949－1950 in Osaka (3,300 MHz)

Fig. 15

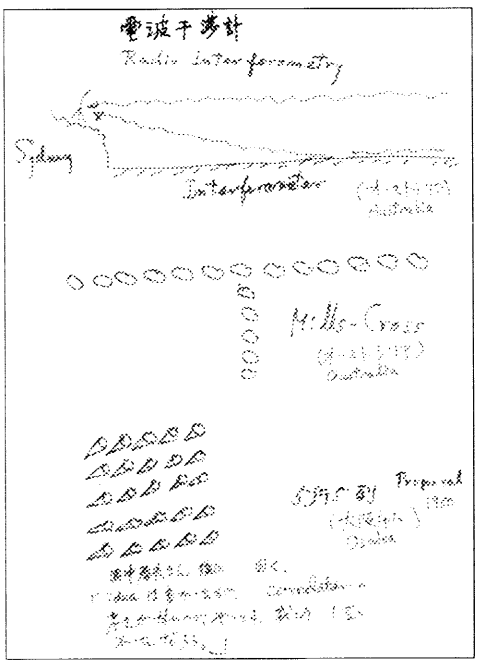
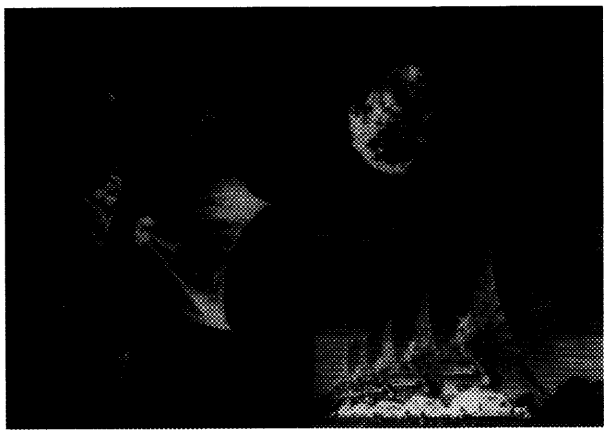


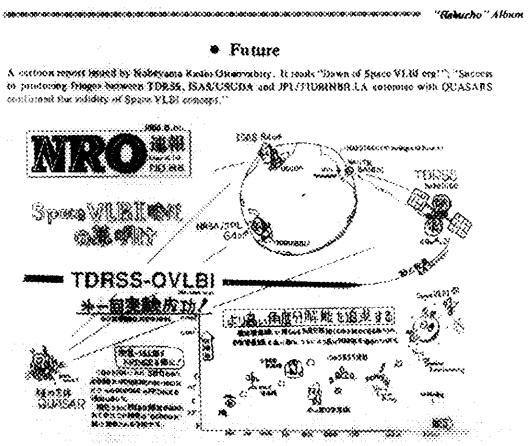
Fig. 16



VSOP antenna ISAS, NAO, JPL, NRAO, AustraliaTelescope, Radio astronomy

Fig. 17

Hirax-Hirosawa／ISAS Engineers



Cartoon by Hirax

Fig. 18

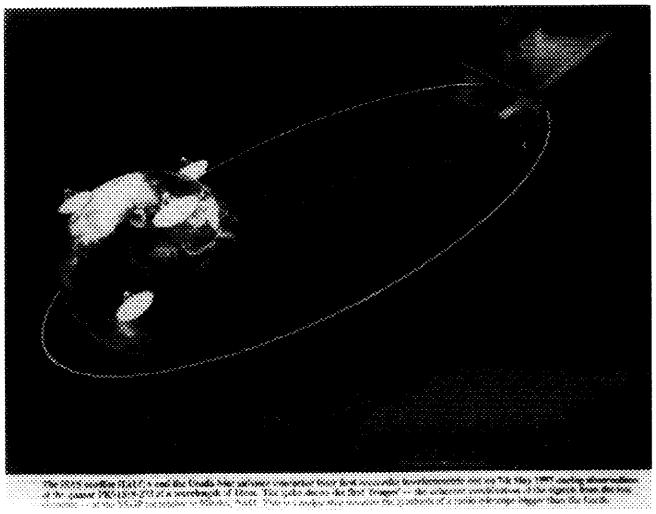
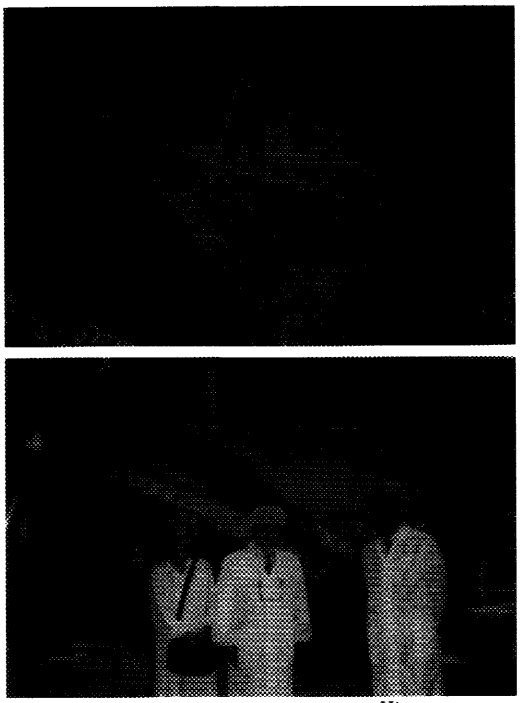
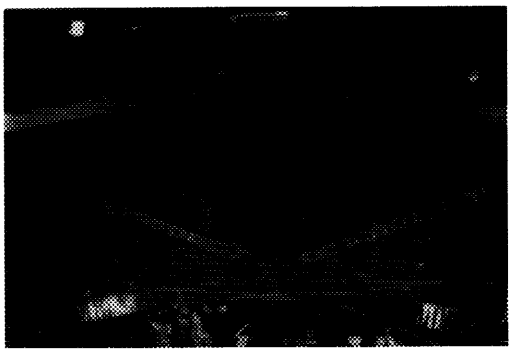


Fig. 19



Hirasawa

Fig. 20



8m parabola extended

gold-plated mesh of molibdenum

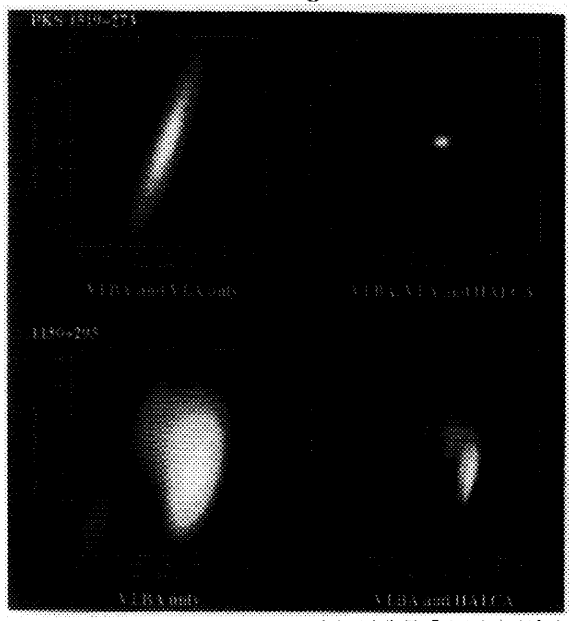
folded by "ORIGAMI" technique

Fig. 21

Photos by Hirax
Feb. 12 '98

Fig. 22

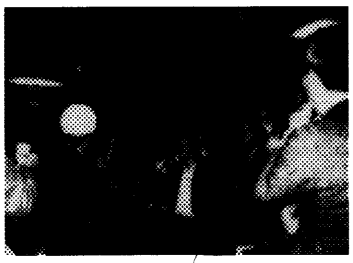
VLBI images



▲電波天文衛星「はるか」がとらえたクェーサー

without VSOP　　with VSOP

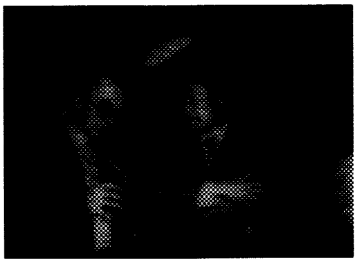
Fig. 23



Culhane

1987 Jan.

Toast for the start of UK · US · Japan SOLAR · A Team



Culhane　　Ogawara —manager

Culhane

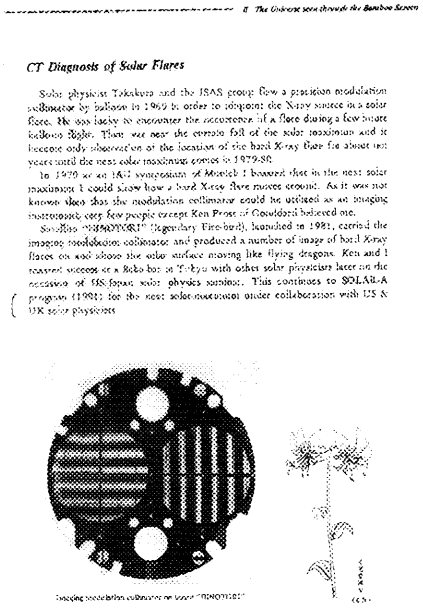
L. Acton

1992 Feb.

Yohkoh symposium

Noto the change of Culhane's hair in 5 years !

Fig. 24



CT Diagnosis of Solar Flares

Solar physicist Takakura and the ISAS group flew a precision modulation collimator by balloon in 1969 in order to pinpoint the X-ray source in a solar flare. He was lucky to encounter the occurrence of a flare during a few hours balloon flight. They were near the certain fall of the solar maximum and it became only observation of the location of the hard X-ray flare for about ten years until the next solar maximum comes in 1979-80.

In 1970 at an IAU symposium of Munich I learned that in the next solar maximum I could know how a hard X-ray flare moves around. As it was not known then that the modulation collimator could be utilized as an imaging instrument, very few people except Ken Frost of Goddard believed me.

Soudino "HINOTORI" (legendary Fire-bird), launched in 1981, carried the imaging modulation collimator and produced a number of image of hard X-ray flares on and above the solar surface moving like flying dragons. Ken and I received success as a Roko-hai in Tokyo with other solar physicists later on the occasion of 5S-Japan solar physics seminar. This continues to SOLAR-A program (1991) for the next solar maximum under collaboration with US & UK solar physicists

Fig. 25

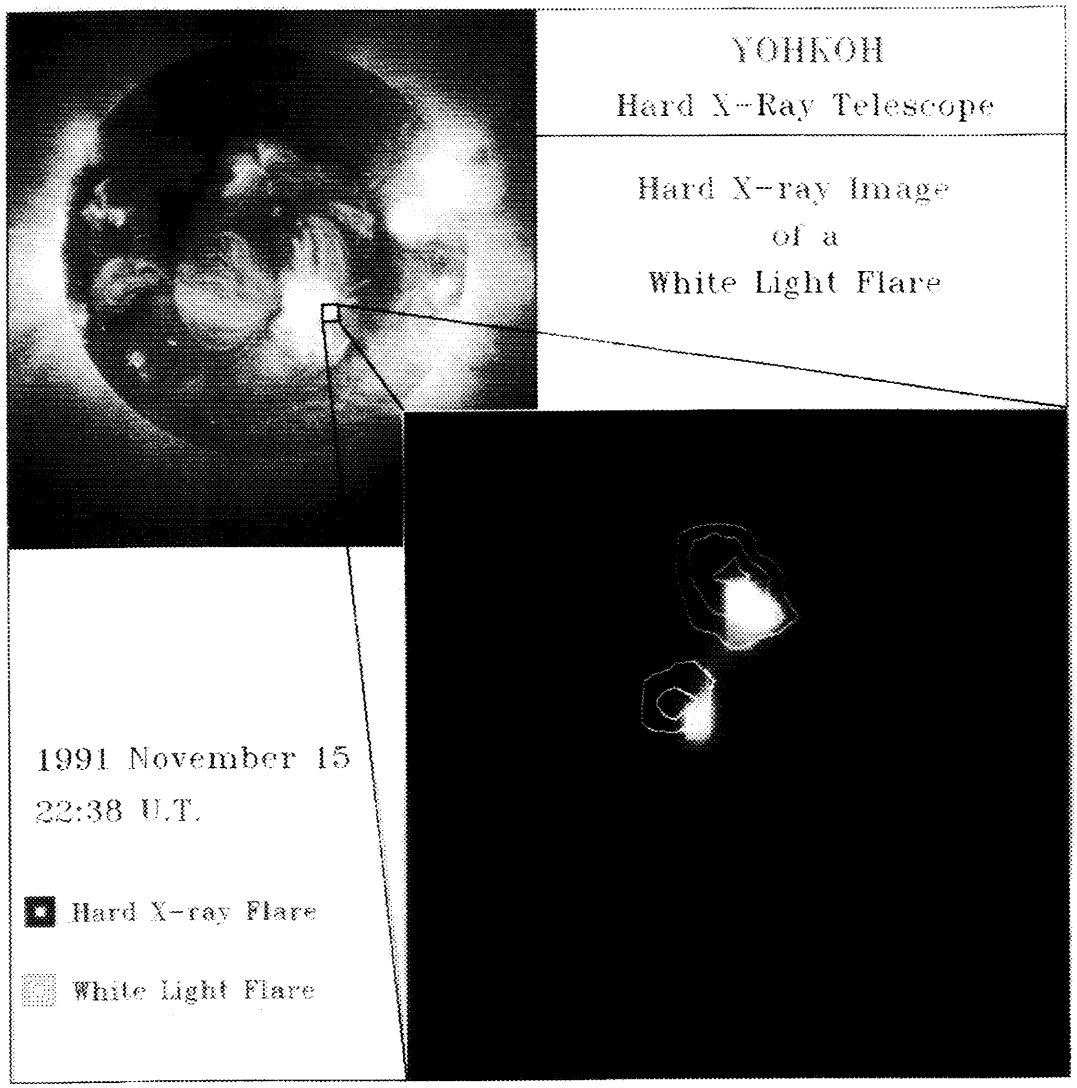
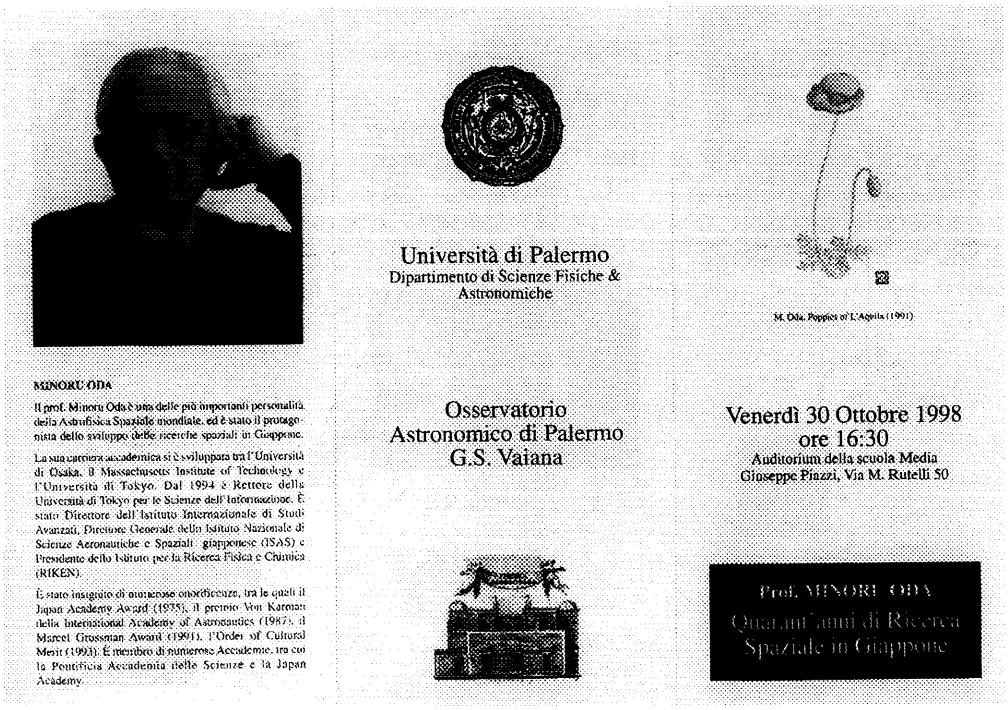
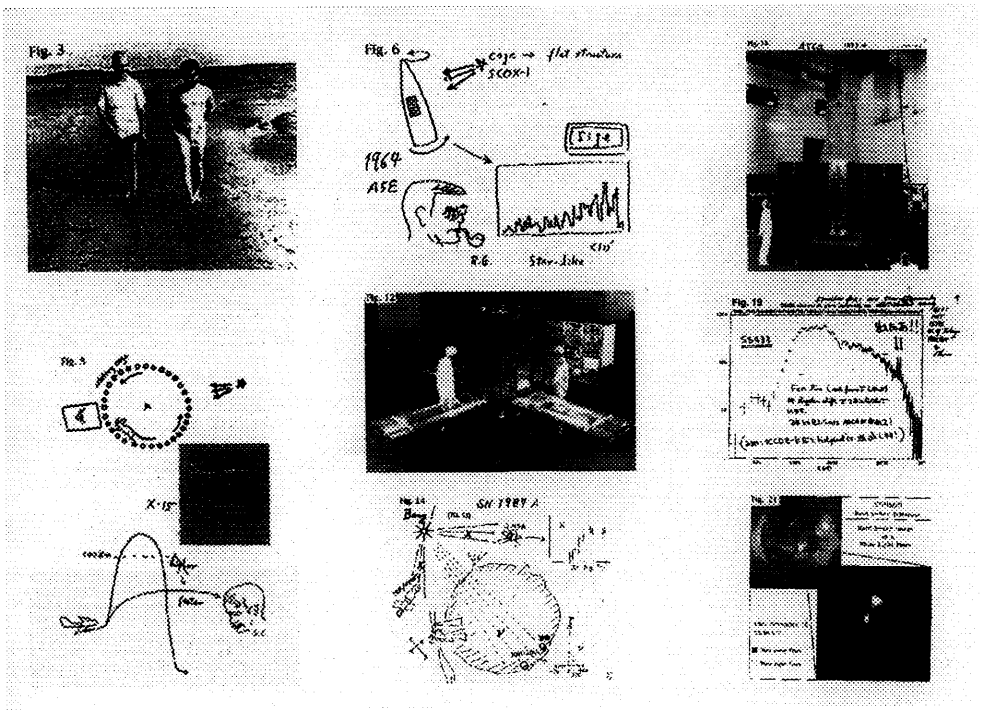

YOHKOH
Hard X-Ray Telescope
Hard X-ray Image
of a
White Light Flare
1991 November 15
22:38 U.T.
Hard X-ray Flare
White Light Flare

Fig. 26





シシリー島のパネルモにイタリア最古の天文台があり、ここともう、30年ほど何かとご縁がありました。10月末に、ヴァチカン科学アカデミーの2年前の定例の総会に出席したついでに、日本の宇宙科学の現状を紹介してほしいという依頼があり、名古屋の COSPAR 総会の話しと同じような話しをしました。【上掲はそのときの紹介リーフレット】